

AD A248356

A RAND NOTE

N-2917-A

Patterns in American Intellectual Frontiers

Carl Builder

August 1990

Prepared for the
United States Army

RAND

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER N-2917-A	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Patterns in American Intellectual Frontiers		5. TYPE OF REPORT & PERIOD COVERED interim
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) C. H. Builder		8. CONTRACT OR GRANT NUMBER(s) MDA903-91-C-0006
9. PERFORMING ORGANIZATION NAME AND ADDRESS RAND 1700 Main Street Santa Monica, CA 90401		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Office of the Chief of Staff Hq US Army (DACS-DMC) Washington, D. C. 20301		12. REPORT DATE August 1990
		13. NUMBER OF PAGES 23
14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office)		15. SECURITY CLASS. (of this report) unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for Public Release; Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) No Restrictions		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) United States History Forecasting Government Economics Patterns Technology Information Sciences		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) See reverse side ..		

This Note examines the notion that a pattern exists in the ideas that have captured and dominated American society. Specifically, over the past 200 years, four such ideas have risen and been widely perceived as the most exciting way to shape the American future, persisting for about 50 years and then giving way to the next idea. Based on that pattern, five earlier ideas can be recognized, going back to the sixteenth century. Having defined a pattern of nine ideas extending over nearly half a millenium, the author suggests three more ideas that might fulfill the pattern for the next hundred years. Looking backward and then forward based on ideas rather than events provides a different kind of projection into the future. Specifically, the events of the past take on a different shading in the context of the ebb and flow of ideas; moreover, the trends may now appear to be in decline or ascendancy. Although understanding the intellectual patterns of the past may not tell us the answer to what is next, it does provide a clearer sense of the domains where new developments should be expected.

23 pp.

A RAND NOTE

N-2917-A

Patterns in American Intellectual Frontiers

Carl Builder

August 1990

**Prepared for the
United States Army**

RAND

PREFACE

This Note interprets the past and speculates about the future by observing patterns in the ideas that have shaped American thinking and America's intellectual energies. It documents an analytical framework that has been used by the author to evaluate current events and project trends in military planning. It should be of particular interest to those involved in futures forecasting for military planning and of general interest to anyone who has studied the past in order to peer into the future.

This Note was prepared under sponsorship of the U.S. Army at the Arroyo Center, the Army's federally funded research and development center for studies and analysis operated by The RAND Corporation. The Arroyo Center provides the Army with objective, independent analytic research on major policy and management concerns, emphasizing mid-to long-term problems. Its research is carried out in five programs: Policy and Strategy; Force Development and Employment; Readiness and Sustainability; Manpower, Training, and Performance; and Applied Technology. This Note is a result of research being conducted in the Policy and Strategy program as an exploratory project on the Army's institutional futures.

Army Regulation 5-21 contains basic policy for the conduct of the Arroyo Center. The Army provides continuing guidance and oversight through the Arroyo Center Policy Committee, which is co-chaired by the Vice Chief of Staff and by the Assistant Secretary for Research, Development, and Acquisition. Arroyo Center work is performed under contract MDA903-86-C-0059.

The Arroyo Center is housed in RAND's Army Research Division. The RAND Corporation is a private, nonprofit institution that conducts analytic research on a wide range of public policy matters affecting the nation's security and welfare.

Stephen M. Drezner is Vice President for the Army Research Division and Director of the Arroyo Center. Those interested in information concerning the Arroyo Center should contact his office directly:

Stephen M. Drezner
The RAND Corporation
1700 Main Street
P.O. Box 2138
Santa Monica, California 90406-2138

Telephone: (213) 393-0411

Accession For	
NTIS GRA&I	<input checked="checked" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	



SUMMARY

Projections into the future are most commonly made by extrapolating trends, such as populations and technology, or by invoking patterns, such as the rise and fall of empires and markets. These projections focus on events; they project future events in the trends or patterns of past events.

In this Note, the future is projected not by events but by ideas. There is a pattern, a cyclical flow and ebb, in the ideas that have captured and dominated American society. These ideas have typically persisted for about fifty years as the dominant intellectual force in shaping American dreams and expectations.

Over the past 200 years, four such ideas have risen to be widely perceived as the most exciting way to shape the American future, only to fall and be replaced by the next. On the basis of that pattern, a sequence of five earlier ideas can be recognized, taking the series back to the sixteenth century. With a pattern of nine ideas extending over 500 years, it does not seem too brash to project forward in time another three ideas that might fulfill the same pattern for the next hundred years.

This looking backward and then forward on the basis of *ideas* rather than *events* provides a different kind of projection into future: The events of the past take on a different shading in the context of the flow and ebb of ideas; the trends in past events extrapolate differently because the ideas that support them may now appear to be in decline or ascension. And the intellectual patterns of the past provide a remarkably long and confident probe for poking into the future: One may not know the answer to what is next, but at least one has a clearer sense of what to look for and where to look.

CONTENTS

PREFACE	iii
SUMMARY	v
Section	
I. INTRODUCTION	1
II. THE LONG WAVE	3
III. INTELLECTUAL FRONTIERS	6
IV. LOOKING FARTHER AHEAD AND BACK	18
V. IMPLICATIONS NOW	20

I. INTRODUCTION

Understanding present events and projecting future events requires some intellectual framework or context: What is going on? Why? Where is it likely to lead? The necessary frameworks are often implicit models of how the world works—what is constant, what is changing, and how those things can interact to produce future events and situations. Sometimes the models are explicit, as in the extrapolation of trends (e.g., population growth), patterns (e.g., economic or market), or cycles (e.g., sunspot activity).

The phenomenal success of Paul Kennedy's recent book, *The Rise and Fall of the Great Powers*,¹ probably reflects the desire of people to have a context in which to understand the events they are observing—events that may affect their lives and therefore trouble or concern them—and to understand where they may be headed. The historical pattern in the rise and fall of great powers can be used as a template to judge what *may* be happening today—where we are and where we may be going.

Where such explicit patterns conflict with others (often held implicitly to that point), they are likely to stimulate some debate on whether the patterns have been correctly interpreted from the past or are being correctly applied to the present or future.² However, their greatest value may not lie in that which is debated—their correctness—but in the windows they provide to look afresh upon the past, present, and future. Their validity may be less important than whether they offer new and interesting vistas. They are, after all, *intellectual* frameworks, mental kaleidoscopes with which to look at new and interesting patterns for *thinking* about things. They can be tested for correctness later, when the time for thinking is coming to an end and *actions* must be contemplated. Indeed, history suggests that they may often not be correct and yet lead to interesting questions and, ultimately, even to "correct" answers.

The conceptual framework advanced here is a cyclical view of American intellectual energies. As a notion, this framework first surfaced for the author about ten years ago in a conversation with an Air Force officer, Lieutenant Colonel Larry Farrell, who suggested that Americans needed new frontiers and seemed always to have found them. Over the

¹Paul Kennedy, *The Rise and Fall of the Great Powers: Economic Change and Military Conflict from 1500 to 2000*, Random House, New York, 1987.

²For some examples, see Charles Wolf, "America's 'Decline': Illusion and Reality," in *The Wall Street Journal*, 12 May 1988, p. 22, and Samuel P. Huntington, "The U.S.—Decline or Renewal?" *Foreign Affairs*, Vol. 67, No. 2, Winter 1988/89, pp. 76-96.

intervening years, the framework has been slowly elaborated and refined through conversations and seminars about the future. It is not the product of dedicated research so much as the collection of thoughts and evidence of the cycling of ideas through the American society.

II. THE LONG WAVE

The perception of cycles in history which can be used to project into the future is certainly neither new nor disreputable. Natural phenomena of all kinds have been seen in cyclical terms: The movements of the Sun, stars, Moon, tides, and on longer time scales, the seasons, climate, sunspots, and earthquakes. The fluctuation of wildlife forms on the planet, such as the lemming (3.86 year cycle), lynx, and salmon (9.6 year cycles), are well documented.¹ Periodicity in human economic activity keeps many chartists merrily occupied with boom-and-bust cycles, predicting recessions, bull markets, etc.

One of the more interesting cycles in human affairs is one that has become associated with the name of Nikolai D. Kondratieff, a Russian professor at the Moscow Agricultural Academy after the Russian revolution. He asserted that that rise and fall of capitalistic economies followed a historical cycle of about 50 years—pure heresy to the Marxists who knew that capitalist economies were destined to fail because of their evil ways. Kondratieff was carted off to Siberia for his views, but the long wave of about 50 years now frequently bears his name.²

Lord Beveridge charted European wheat prices from 1500 to 1869 and came up with a 54-year cycle. Subsequent analysis of English wheat prices by Dewey back to the year 1259 confirmed that same 54-year cycle over a span of more than 700 years.³ This is a fascinating periodicity because it shows up in all sorts of other phenomena, in both human and natural affairs. Fifty-four year cycles are apparently evident in such diverse things as

¹See Edward R. Dewey with Og Mandino, *Cycles: The Mysterious Forces That Trigger Events*, Hawthorn Books, New York, 1971, pp. 24-28.

²James B. Shuman and David Rosenau, *The Kondratieff Wave*, Dell Publishing, New York, 1972, pp. 29, 30. Some more recent references are:

Earnest Mandel, *Long Waves of Capitalistic Development: The Marxist Interpretation*, Cambridge University Press, Cambridge, MA, 1980.

J. P. Warren, *The 50-Year Boom-Bust Cycle*, Cameron & Co., San Francisco, CA, 1982.

J. J. van Duijn, *The Long Wave in Economic Life*, Unwin Hyman, Winchester, MA, 1983.

Christopher Freeman, Editor, *Long Waves in the World Economy*, Francis Pinter Publications, Dover, NH, 1984.

Nikolai D. Kondratieff, *The Long Wave Cycle*, a new translation of his 1928 thesis, *Long Economic Cycles*, Richardson & Snyder, New York, 1984.

Joshua S. Goldstein, *Long Cycles: Prosperity and War in the Modern Age*, Yale University Press, New Haven, CT, 1988.

³Dewey, *Cycles*, pp. 96-98.

prices and interest rates, the number of international battles, sunspots, and tree rings.⁴ At some point, all this numerology takes on the color of cultism. To their credit, however, most cycle students are cautious about the relationships or meanings behind the observed cycles. Some of the observed cycles are yielding to study—e.g., the predator-prey relationships and their time constants. Few of us would now dismiss the natural cycles, such as the sunspots or the return of the swallows, even if we don't yet fully understand them. But we tend to be very skeptical of such rigid periodicity in human affairs: After all, isn't it we, and not the cycles, who determine our fates?

Nevertheless, the long-wave cycle keeps popping up: Goldstein has advanced a theory, supported by statistical analyses, of the relationships between human conflicts and economics:

Since 1495, long waves are identified in great power war severity [numbers of casualties] and in internationally synchronized trends of prices and real wages.⁵

And Marchetti has shown that the transportation infrastructures in the United States were developed in cycles that correspond to the long wave.⁶ Canal building peaked in 1835; railroads reached that point in 1890; paved roads in 1945; and the development of airways now appears on track to reach that same point in 1995. Each new cycle started as the previous one peaked.

The penchant of economists to provide explanations for otherwise unfathomable phenomena—such as movements, or the lack thereof, in the markets—is evident in this explanation of the long wave:

One explanation for the long wave holds that business investment builds to the point where there is more productive capacity than demand for the output. In the process, there's a huge debt buildup. Then comes a prolonged shakeout, during which some of the capacity is scrapped and debt is repudiated. Recovery occurs when a new round of investment begins, usually around a previously known but little-employed technology, such as railroads in the 1850s.⁷

⁴Edward R. Dewey, "The 54-Year Cycle," *Cycles Magazine*, April 1988, pp. 82-83.

⁵Joshua S. Goldstein, "Long Waves in War, Production, Prices, and Wages," *Journal of Conflict Resolution*, Vol. 31, No. 4, December 1987, p. 573.

⁶Cesare Marchetti, "Swings, Cycles and the Global Economy," *New Scientist*, May 2, 1985, pp. 12-15.

⁷Ralph Winter, "Prudence Will Pay in a Slow-Growth Decade," *The Wall Street Journal*, August 22, 1988, p. 11.

What that explanation leaves hanging is the question of why the process seems consistently to require fifty or so years, across centuries, even though the elements in that process—technology, human lifespans, communications, etc.—have been changing dramatically. The long waves don't seem to reflect the accelerating pace so often attributed to the modern world.

There is no need here to argue the validity, the underlying theory, or the implications of the appearance of long wave phenomena in human affairs. The applications of long-wave theories have been described briefly only to suggest that the concept of periodicity in human intellectual energies is not without some precedent. While that neither adds nor subtracts from the merits or validity of the following theory of American intellectual frontiers, the considerable number of long-wave observations does make that theory a little less bizarre than it might otherwise appear.

III. INTELLECTUAL FRONTIERS

American excitement over new intellectual frontiers appears to have ebbed and flowed in 50-year cycles. Intellectual frontiers can be defined as a *collective perception* of

- Where the most exciting future lies,
- The boundary which is in greatest movement,
- The activity which offers the most potential for individual and societal development,
- The idea that captures the imagination and dominates much of the thinking of a society for a generation or more.

Such ideas are important because they focus a society's energies and set its directions. The ideas may not be strictly correct; they may, indeed, with time, prove to be false; but they are the intellectual engines of a society, imbuing it with both motivation and direction. They are *intellectual* rather than physical frontiers because the movement is mostly conceptual—inside people's minds—and not always truthfully reflected in physical facts or demonstrable accomplishments. The flow and ebb of International Communism in this century is an example of such an intellectual frontier for some societies—an idea that served, at least for a while, as the intellectual engine for a society, motivating actions and building enthusiasm, even though that idea might not be fully supported by objective facts or accomplishments.

The American intellectual frontiers appear to peak at 50-year intervals, each frontier rising and falling over a 100-year span. As one frontier is peaking, the previous one is closing and the next one is beginning to open. For each new frontier, there is a 50-year ascendant phase marked by growing enthusiasm for the idea and its potential and by growing numbers of adherents or participants in the dream. At its peak, the idea provides American society almost unbounded optimism for its promise; and much of society has adopted its premises. The peaking of the frontier is then followed by a 50-year declining phase, marked by increasing excesses and abuses of the idea, and ultimately in disappointments or disasters rooted in excessive faith or optimism. In effect, it is an intellectual boom-and-bust cycle—a bull and then a bear market for some idea that dominates the American society. The transition between frontiers may indeed be a market phenomenon:

One of the most important features of the American national style is optimism. What happens . . . is that a shift in the demand preference of consumers of ideas takes place. As one frontier peaks in acceptance and then begins its decline, there has been a willingness and indeed a desire to search for meaning in some new framework.¹

The ascendant phase or leading edge of each intellectual frontier is populated by enthusiastic visionaries who eagerly anticipate its peak, while conservatives, still attached to the previous idea, try to diminish or disparage its importance. The descendant phase is then dragged out by a new set of conservatives who have built their lives around the dream and try to sustain it forever. However, the dynamic between the two is that "more people embrace the new, otherwise there would be no pattern. What this reminds one of, of course, is the concept of 'creative destruction' embedded in the capitalist system of development One era is not only open to new concepts, but relishes trouncing the concepts of the previous era."²

The ascendant phase may have a long, thin leading edge of antecedents which are detectable for as much as 100 years before the peaking of the frontier,³ but the apparent rise seems to occur in the 50 or so years before the peak. The declining phase may also have a long tail due to those who hang on to an idea long after society has assimilated it and moved on. More than 50 years after the closing of the American West, one can still find cowboys and gun-slingers at heart and in dress.

The concept of intellectual frontiers does not mean that ideas appear and then completely disappear or are discredited. The intellectual frontiers described here are identified with thinking or ideas that rise and fall in their extent and in the degree of enthusiasm they engender, but the *products* of that thinking may persist, even continue to grow over time. For example, in the 1950s, the American public had a brief but intense "love affair" with its automobiles—a fad or fashion rather than an intellectual frontier because of its content and brevity. After the infatuation ended, the sale of automobiles continued, eventually even increased. But the love affair—the idea, the relationship, that particular kind of thinking—had largely disappeared. The American society still recognized the idea, but it had mostly moved on to other preoccupations.

¹Paul Bracken, commenting on an earlier draft of this Note in a letter dated May 17, 1989.

²Bracken.

³The possibility of a long leading edge for each wave was first suggested to the author by E. B. Vandiver III.

Some have suggested that these intellectual frontiers are cumulative: Each successive frontier builds upon—is facilitated by—the last frontier. The point is correct, but it tends to blur that which should be made most distinct: The intellectual frontiers are *identified* with ideas; but they can be commonly *measured* by the extent and intensity of society's enthusiasm for those ideas; and those things do rise and fall rather than accumulate or accrete. The public enthusiasm for nuclear power rose and then fell in American society, but the number of nuclear power plants generated by that wave of enthusiasm did not rise and then fall in proportion—they accumulated according to the familiar "S" curve.

Although the cycling of intellectual frontiers may not be unique to American society, it may have been more evident or pronounced in our history. America has been a frontier for much of the Western World—a place where dreams could be pursued—from its discovery right down to the present.⁴

What follows is the description of a series of American intellectual frontiers. Four of them appear to be clearly discernible in the history immediately behind us. The next peak ahead can be read from the evidence of its beginnings in recent history. Beyond that, several more can be dimly seen. With six or seven such frontiers described, one is easily emboldened to speculate backwards for as many as five earlier frontiers.

The Governmental Frontier

There was a time in North America, if not the Western World, when the most exciting ideas of a generation centered on new and innovative forms of government. Many people, including the founding fathers of the United States, believed that they could most effectively create and nurture more perfect societies through the design of governments. Through the design of its government, the thinking went, a society had almost unlimited power for its prosperity and happiness. The American *Declaration of Independence* and the *Constitution of the United States* are documents which reflect that spirit and dream. At the same time, a number of smaller communities, such as the Oneida Community, were experimenting with new theories for communal governments.

This thinking was an intellectual frontier. It was marked by excitement, ferment, experimentation, and dreams of almost unlimited power for societal good or benefit. If a society could find the right form of government, it could become almost anything, do

⁴Paul Bracken observes, with emphasis, that it "is no accident that *every* intellectual frontier mentioned [here] is a product of the capitalist system (i.e., not a feudal system, not a communist system, not a traditional system, etc.)."

anything it dreamed of becoming or doing. That excitement probably peaked around 1800 in the United States; the excitement appears to have been widespread in society—at least among those who had the time, energy and capacity for intellectualizing about such things. It probably started to take hold as a significantly shared idea about 1750, and I would argue that it largely died out, as a frontier, by about 1850. By 1850, the governmental frontiers which had been probed and pushed by Hamilton, Jefferson, and Marshall were largely closed, and the American Civil War would soon resolve the last major question of state and federal powers.

After 1850, certainly after 1865, few would be found with the intellectual fervor or fever for the design of new governmental forms that characterized the decades on either side of 1800. Americans had found, explored, and painfully tested their concepts in government. That frontier had closed. Besides, there was no time to lament its closing; there was a new one to reckon with.

The Land (Western) Frontier

Although a land frontier existed from the beginning of the settlement of North America, the *intellectual* idea of the American land frontier began around 1800, at about the time of the Louisiana Purchase. That idea reached its zenith by about 1850 with a frenzy of acquisitions or settlements—Maine, Texas, all of the territories now occupied by the Western States, and Alaska. And that frontier closed around 1900 with acquisitions of the Spanish-American War and adjustments of the Mexican border.

The land frontier is what most Americans still associate with the word frontier. In that context, it was a place and time. But it was also an *idea*, an ethos, a concept of life and living. The boundless land represented more than open or untamed country: It was an almost unlimited opportunity for freedom and enterprise. If one had the courage and strength to seize that opportunity, one could do almost anything and become almost anything. That intellectual dimension of the land frontier is what fired the imagination of American society, not just the pioneers who pushed westward. It was Horace Greeley (1811-1872) and Francis Parkman (1823-1893) who expressed the intellectual idea of the land frontier in their writings for those who stayed home, while the art of Frederick Remington (1861-1909) captured some of the nostalgia of its waning, and historian Frederick Jackson Turner (1861-1932) was able to see retrospectively the many significances of the land frontier in American national development.

The shift from the governmental to the land frontier was not easy for some:

In the War of 1812, a good many Federalists would have preferred to see the British win rather than to see the locus of national power pass to the American West.⁵

Perhaps the passing of the land frontier was (and remains) more lamented than any other, but by 1900, a new intellectual frontier was already at its zenith.⁶

The Industrial (Production) Frontier

What I have chosen to call the industrial frontier is the idea that the growing prowess of industry—steel, chemical, transportation, manufacturing—offered new and unlimited opportunities to make society rich beyond its dreams in goods and amenities: With industry, one could make anything, anywhere. Steel-girdered buildings could be made so high as to scrape the sky. Trains could travel at the speed of a mile-a-minute. A canal could be built across the Isthmus of Panama. Electricity and gas could be brought into the urban home. Industry was providing the means—the materials and machines—for mastering the natural environment, which had been, up to that time, so daunting. Industry could conquer both nature and other nations.

The industrial frontier began around 1850 in the United States with the first mass production factories and foundries in the Northeast. Certainly the excitement and power of industrial prowess, as an idea, was already evident in the prosecution of the American Civil War. By 1900, the nation was fully seized with its fever: It was the time of the "industrial barons." Fortunes awaited the captains of industry, and a cornucopia of new goods and capabilities was being offered to a dazzled society. But, by 1950, the freedoms of the barons had been sharply curtailed by antitrust, labor, and tax laws, and American society had shifted its adoration to the marvels of technology rather than the largess of industry. Industrial capabilities came to be accepted as routine. Almost anything that could be invented or devised could be produced in quantity by industry.

⁵Richard J. Barnet, "Rethinking National Strategy," *The New Yorker*, March 21, 1988, p. 109.

⁶The U.S. Census Bureau declared the American frontier closed in 1893. (Robin Higham and Carol Brandt, editors, *The United States Army in Peacetime*, Military Affairs/Aerospace Historian Publishing, Manhattan, KS, 1975, p. 3.)

World War I was fought with the thinking of the industrial frontier. Machines and chemicals—the products of industry—could mass produce death with machine guns and poison gas. It was perhaps the first major societal disaster to be associated with the industrial frontier. “Daddy Warbucks” of the comic strip, “Little Orphan Annie,” was initially introduced derisively as a symbol of the role of the industrial barons in World War I. World War II, barely 20 years later, was largely prosecuted through industrial means, but it also bore the mark of the new and ascending intellectual frontier.

The Technological (Gadget) Frontier

The technological frontier made its recognizable debut when the industrial frontier was at its zenith. It differed from the industrial frontier in both its sources and products. The technological frontier rested on scientific knowledge being deliberately applied for the invention and design of intricate gadgets⁷ whose principles were not obvious or fully understood by most of society. These gadgets, like the radio and airplane, were the one-off inventive devices of scientific tinkerers, not the mass produced materials or machines of industrial artisans and engineers. These technological marvels dazzled society by the mysteries of their working and by their promise of things to come when produced in quantity by industry.

The emphasis was on scientific knowledge and gadgets, not on production or construction or dissemination or utilization, to name a few other possibilities. The excitement was with science, deliberately applied in the laboratory, providing the means for devising an intricate gadget—mechanical, electrical, chemical, nuclear, or some combination thereof—to fulfill some purpose. To be sure, many of the technological gadgets were eventually produced in quantity by industry, but the intellectual excitement was with the technological frontier that was being pushed, not with the industry that could replicate the gadgets.

It is important, here, to distinguish between industry and technology because the separate role of each suggests what may lie ahead. The products of industry were not principally gadgets. They were materials—such as iron, steel, and chemicals—and machines for

⁷The word, *gadget*, is used here to distinguish between technology in the general sense—applied science—and technology as “the totality of the means employed to provide *objects* necessary for human sustenance and comfort” (*Webster’s Ninth New Collegiate Dictionary*, emphasis added). Thus, radar is a technological gadget; but *utilizing* the information from radar stations to defeat the Luftwaffe over Britain in the summer of 1940 was less technological than it was a conceptual and organizational use of information.

the conversion of energy—such as locomotives, generators, and presses. These products were developed more through engineering art and practice than by scientific knowledge. Two examples will illustrate the differences between the thinking of the two frontiers.

When the first electrical power lines from a small hydroelectric plant were brought into the mining town of Bodie (now a ghost town) in California in 1892, the line construction crew took great care to ensure that the routing of the lines involved gentle curves. They were concerned that any sharp, right-angled bend might cause the electricity flowing through the lines to fail in negotiating the bend, to shoot out of the lines, and be lost.⁸ Their knowledge of electricity, obviously, was not scientific, but based on the practical engineering arts and practices of water lines and aqueducts—the utilities with which they had experience. Their caution can be contrasted with that of the Wright brothers, who, only a few years later, were systematically testing airfoil shapes in their home-built wind tunnel before constructing a machine to carry them into the air.

In the early 1900s, William Mulholland engineered a giant aqueduct to bring water from the Sierra to Los Angeles. He used huge, riveted iron pipes as siphons to carry the water across the deep canyons that cut through the path of the aqueduct. After testing one of these siphons for leaks, the water supply was abruptly shut off; the momentum of the water in the siphon then created a vacuum which collapsed the pipe. In dismay, one of the construction crew asked Mulholland what they should do now. He is reported to have correctly surmised that if the force of the water collapsed the pipe, it should also be sufficient to open it again. Such “let’s-try-it-and-see” approaches of the industrial frontier may be contrasted with the deliberate, comprehensive approaches to the making of the atomic bomb only 40 years later.⁹

Throughout the first half of the twentieth century, technology leapt ahead with new and amazing gadgets that promised so much for the future. Although some of these things—such as the radio and airplane—were beginning to be produced in quantity, most of them appeared in the laboratory and were experimental in nature—such as television, helicopters, and radar. These were not marvels of industry, but of the laboratory; and they relied on the application of scientific knowledge for their conception and development.

⁸Barbara Moore, “Bodie Electrifies the World,” *The Album* (Chalfant Press, Bishop, CA), Vol. I, No. 3, July 1988, p. 7.

⁹See Richard Rhodes, *The Making of the Atomic Bomb*, Simon & Schuster, New York, 1986.

By 1950, technology was the dominant intellectual frontier. With the miracles of technology—radar, atomic energy, jet planes, space rockets—one could do anything desired: go to the Moon or Mars, make a better, more comfortable life for society with gadgets and power to do anything one might want, even reduce an enemy's society to the stone age.¹⁰ Traditional military concepts were the first victims in this "extraordinary technological revolution of the twentieth century and, in particular, in this revolution's first dramatic product, the airplane. The airplane and its technological descendants, missiles and spacecraft, in many respects continue to constitute one of the most challenging products of the revolution in terms of impact on national strategy, on military policy and thinking"¹¹ At its zenith, technology offered what industry had promised only 50 years earlier—unlimited potential to change American society for the better. The American public had once again found what it had always found in its new world—a new pathway or means to a better future.

But at the end of the 1980s, it is apparent that this frontier, like the others before it, shows signs of closing down. The optimism of the 1950s for technology has waned; technology isn't, after all, an unalloyed good: It has its disappointments, its limits, its unwanted—sometimes disastrous—side-effects. This declining enthusiasm for technological solutions doesn't mean that technological efforts are closing down or disappearing—any more than industry, land, or the government are closing down or disappearing. Rather, it is the intellectual frontier—the *widespread excitement with the idea* of what can be done with technology—that is waning.

Since most of us have lived our lives near the peak of this intellectual frontier, it is difficult for us to develop a good perspective of it. Those of us over 50 will have clear memories of its ascending phase and are likely to be much more positive about technology than those who are under 40 and have memories only of declining enthusiasm. And to even suggest that technology—as an intellectual frontier—is declining will set on edge the teeth of those who have built their lives and livelihood around technological endeavors. Such a suggestion is as popular today as would it would have been to tell an industrial baron of the

¹⁰In retrospect, it seems so appropriate that the Los Alamos scientists referred to the first implosion-type atomic bomb, the design that dominated their development and testing efforts, as the "gadget." Although that name undoubtedly masked the highly classified nature of their efforts, they were, nevertheless, developing the ultimate gadget of a gadget age that began about 1900 and seems destined to go until about the Year 2000.

¹¹Vincent Davis, *The Admirals Lobby*, The University of North Carolina Press, Chapel Hill, 1967, p. 48.

1930s or a Texas cattle baron of the 1880s that his era was coming to a close in a decade or so. The myth of the technological frontier is that technology is ever-accelerating or compounding. Scientific knowledge certainly is, but the applications of that knowledge to devising gadgets are growing more slowly.

A good example is the airplane, the gadget that heralded the real beginning of the technological frontier. The myth says that aircraft technology is accelerating, that aircraft are being made obsolete by technological advances at an increasing pace. The opposite may be more correct. Indeed, aircraft design lifetimes are increasing in direct proportion to the age of the technological frontier. The useful lifetimes of the best civil aircraft designs have always been about equal to the age of powered flight at the time of their design. That applies equally to the Jenny, the DC-3, or the 707. The best military aircraft designs have had useful lifetimes that are about half the age of powered flight at the time of their design; and that applies equally well to the DH-4, the F4U Corsair, or the F4 Phantom.

While technologists might prefer to replace aircraft at a constant or accelerating pace, the economics of good design dictate just the opposite. Instead of the aircraft, it is their electronics that are being replaced. The cutting edge of performance, for aircraft at least, is no longer to be found in the airframe or its propulsion, but in the electronic—the information—systems on board.¹² Is that simply technology in another form? Perhaps not. What is happening with electronic systems—in airplanes as everywhere else—may be a manifestation of a new frontier, as different from the technological frontier as the technological frontier was from the industrial frontier.

If the pattern of American intellectual frontiers for the last two centuries persists—something which cannot be taken for a certainty, but certainly worthy of entertaining for speculative purposes—then the technological frontier should be pretty much closed down by the Year 2000. This implies that technology will have become a routine part of society and its expectations—something that will be both praised and damned, but not something that any longer captures and holds the imagination of American society as a whole. Just as industrial production is something taken for granted as understood and routine, so will the innovation in technological gadgets: If there is a market for a new gadget, technology will probably be able to create it, and industry will probably be able to produce it. Whether or

¹²In the recent agreement between the United States and Japan to cooperate in the development and production of an advanced fighter aircraft, the United States agreed to provide all of the requisite *hardware* technology, but deliberately withheld from transfer the more valuable *software*.

not those public perceptions of technology are objectively correct need not be argued, for such perceptions and enthusiasms are the engines of American society. If most Americans are no longer in love with technology—just as they long ago lost their adoration of industry—then that change will affect the future of America.

If the American adoration of technology is on the wane, then the pattern of American history suggests that American society is already deeply in love with a new idea and means to a better future. The new intellectual frontier should have begun to open up about 1950—perhaps lost from sight in the peak of excitement and enthusiasm for the technological frontier then at its zenith—and this new frontier should now be well along in its ascendant phase. Indeed, if the pattern described here holds, we should now be only a dozen or so years from the zenith of a new frontier of American enthusiasm. It doesn't take much pondering to see what that new frontier is. But, as with the subtle distinction between industry and technology, it is necessary to separate technology from its successor—information or cybernetics.

The Information (Cybernetic) Frontier

Many have described current events to be a part of the "Information Age." If information is the right label to put upon the intellectual frontier that is now in its ascendant phase, then four signs should be evident:

1. The intellectual frontier should evidence some modest, but apparent, beginnings in developments around 1950.
2. The excitement and enthusiasm for the ideas associated with this frontier should be increasing rapidly.
3. The central ideas should be capable of capturing the excitement and enthusiasm of much of American society.
4. Those ideas should be perceived by much of society as promising unlimited power, to make a better life or to permit Americans to be almost anything or do anything they want.

The first two signs are evident enough: The 1950s brought television, satellites, and computers out of the laboratory—some of the basic building blocks of the Information Age.¹³ And the excitement about the power of information communication, processing,

¹³Electronic computers were first used in 1943 to break the German codes—a

management, dissemination, control, access, storage, etc.—whatever the number of their devotees—is certainly waxing, not waning.

One measure of the escalating interest in the power and promise of information is the investment of American society in information-related durable products as a fraction of the total investment in durable products. If we are on the ascending side of the wave for the information frontier, that fraction should have been small in 1950, rising slowly at first, but more rapidly in the 1980s, now becoming a significant share the total. Indeed, that is the situation:

About 40 percent of all new investment in plant and equipment in the United States now [1988] goes to purchase information technology—computers, telecommunications devices, and the like. Just 10 years ago, the share was only 20 percent. That startling jump is one of the few concrete measures of a fundamental transformation under way in the American economy. . . .¹⁴

In 1950, that share was only about six percent, in 1960 about 10 percent. The inflection point in the “S” curve appears to have occurred in the early 1980s. If the peak is around the Year 2000, the maximum share may increase to about 60 percent before declining.

The last two signs pointing toward a new intellectual frontier require more subjective judgment to discern or project: Will many in American society be captured by the excitement of what they can do—or have done for them—with information? And will they believe that there is almost unlimited power or opportunity to change or improve themselves or society through information? While the answers to both questions can't be given before the fact of the next peak, the information “revolution” seems more likely than any other to fill the bill over the next several decades.

A useful test question for identifying the subject of the next intellectual frontier is whether people will come to believe that they can win wars with it. At the peak of the industrial frontier, in 1900, people certainly thought that they could win wars through industrial might. At the peak of the technological frontier, in 1950, people generally thought that technological prowess could win their wars. Now, one can see signs, throughout the American military, that people are beginning to believe they can win wars through information.¹⁵

significant event marking the beginnings of the information age or frontier. See Jozef Garlinski, *The Enigma War*, Charles Scribner's Sons, New York, 1979, pp. 147-149.

¹⁴Colin Norman, “Rethinking Technology's Role in Economic Change,” *Science*, Vol. 240, No. 4855, May 20, 1988, p. 977.

¹⁵Stealth aircraft, antisubmarine warfare, ballistic missile defense, air defense

As a result of the development of technology, warfare becomes more and more a battle of information rather than a battle of firepower. . . . And, as the importance of information increases, we see a gradual shift in the balance of advantage from attack to defense.¹⁶

penetration and suppression, early warning systems, and much more, are mostly about acquiring and denying information, with information processing, management and communications capabilities as *the* pivotal aspects. The failure of an electronic countermeasures (ECM) system—an information acquisition and denial system—to meet its specifications is the most expensive disappointment of the B-1B bomber program.

¹⁶Freeman Dyson, *Infinite in All Directions*, Harper & Row, New York, 1988, p. 223.

IV. LOOKING FARTHER AHEAD AND BACK

If we are now in the ascendant phase of the information frontier, what is the next powerful idea that is likely to capture the imagination of American society? What concept is likely to offer unlimited power to change society? What idea might develop and build upon the fruits of the current information frontier, just as each frontier has built upon the previous? Since that next frontier should show some evident, if modest, beginnings around the Year 2000, it isn't too early to look for some of the earliest harbingers associated with an extended leading edge back to 1950.

One promising candidate for the next frontier is genetics. If the pattern holds, the efforts engendered in pursuit of the information frontier, at or near its peak, should provide some of the first evidence of an ascending frontier for genetic developments. By 2050, the genetic frontier should be at its zenith—a time when much of American society will see unlimited potential through genetics: to make disease-free humans, to feed billions of mouths, to control the planet's biosphere, to produce unlimited power¹ through controlled biological processes, etc. Not everyone may relish those prospects at this early point; but we are, after all, in the descendant phase of a technological frontier where there is growing disillusionment with what people might do with technology (which may not yet be fully distinguished from industry or information or genetics as *motivating concepts*). By 2050, American society may have a greatly different picture of its circumstances, values, and priorities from those of today—perhaps much altered by the information frontier with which it is now increasingly engaged.

After that? Perhaps, after the genetic frontier, space will finally become tractable as a new frontier. With unlimited, regenerable power from controlled biological processes and with altered, better-adapted species, extended traveling and living in space will finally become feasible on a practical scale.

Now that genetic engineering is rapidly becoming a practical proposition, it is not absurd to think of redesigning terrestrial creatures so as to make them viable in space or on other celestial bodies.²

¹As Freeman Dyson puts it, "there is a good chance . . . genetic engineering [will] fulfill the promise of a cleaner and more livable world for mankind, the promise which nuclear energy once made but was never able to fulfill." (*Infinite in All Directions*, p. 156)

²Dyson, *Infinite in All Directions*, p. 104.

Thus, the "Space Age" might come, after all, in the last half of the twenty-first century rather than in the last half of the twentieth century as some have eagerly proclaimed.

If the pattern just described and projected is accepted only as a frame of reference for speculation, it suggests that events over four centuries (from 1750 to 2150) might be associated with the salient human ideas of the time.

Can the pattern be identified even further back in time? Perhaps that task should be left to better historians than the author, but a quick glance over the shoulder suggests some ideas to associate with frontier thinking and, therefore, with American endeavors of the time:

- The mercantile (trading) frontier, peaking in 1750, when the dominant intellectual idea in America was finding profitable trading patterns—in molasses, slaves, tobacco, cloth, tea, spices. Fortunes were to be made in finding out what could be exchanged for what, where, sometimes in complex loops, so that the costly transportation system—ships and wagons—was always full of goods.
- The colonial (franchise) frontier, peaking in 1700, when the idea was to secure patents or franchises to land—the rights of governing and taxation in exchange for investments to develop the land for agricultural production.
- The religious (freedom-from-persecution) frontier, peaking in 1650, when the establishment of separate religious communities in America was the avenue to intellectual pursuits without persecution from the crown or established church.
- The exploitation (ripping-off-the-riches) frontier, peaking in 1600, when the extraction of the most available precious metals and stones was the principal preoccupation of those traveling to and from the New World.
- The exploration (discovery) frontier, peaking in 1550, when the dominant intellectual idea was to find out what was there for the taking—untold riches, a fountain of youth, a water passage to the Orient.

Each of these looks like it might have enjoyed a period of several decades when it dominated the imagination and thinking of people who were shaping America at the time; and each may have had some significance over a span of about 100 years. If something like those five cycles could be worked out, the overall pattern might be stretched to span six centuries.

V. IMPLICATIONS NOW

Looking so far backward for patterns that can be projected so far forward should be more than entertaining; it should provide a framework for reinterpreting the recent past, for a new appreciation of the present, and a more-than-intuitive guess about the near future.

While such revisionist and speculative looks may not be interesting, useful, or correct, it would be a shame not to take advantage of the framework—to climb up on the structure of patterns and take a look around: If we are late in the decline of the technological (gadget) frontier and only about ten years away from the peak of the information (cybernetic) frontier, what should we see looking over our shoulders, at the ground under our feet, and just ahead of us? If what we see surprises us or runs counter to our prior expectations, there is always time enough to look for other evidence or frameworks that will deny or affirm what has caught our attention.

Behind us, over the past ten or twenty years, we should see increasing disillusionment with the promises of gadget technology, even as the technologists promise us more. Technological solutions, while still sought, increasingly seem either not to work or to turn sour. Several examples come to mind: In Vietnam, one technological fix against North Vietnamese infiltration, a sophisticated barrier of sensors named "McNamara's line," didn't work, while another, a defoliant called Agent Orange, worked but turned sour. The supersonic transport, a gadget from the middle of the decline, may not outlast jet transports developed near the peak of the technological frontier, yet technology enthusiasts are now touting the virtues of a hypersonic transport. Nuclear energy for bombs, ship propulsion, and electrical power was one of the outstanding miracles at the peak of the technological frontier, but 30 or 40 years later we are confronted with the awesome cleanup and consequences of its residues and disasters.

Whereas technology seemed to be the bearer of nothing but wondrous, surprising gifts during the first half of the century, late in the last half it seemed to have promised more than it delivered and, even then, with headaches more memorable than the fixes. Did technology turn on us?¹ Of course not! It was our expectations—our perceptions, in a rolling, growing snowball of enthusiasms—that began to outrun the reality as we crested the peak of the

¹Or as Freeman Dyson poses the question: "Why have our efforts to apply science fruitfully to human needs in recent decades been so conspicuously unsuccessful?" (*Infinite in All Directions*, p. 139)

technological frontier. On the ascending side of that wave, prior to 1950, we were on the declining side of the industrial frontier; we were still looking toward industry to fulfill its promises even as we were being disappointed by many of its consequences for society. The ascending technological frontier, while heralded by some, came bearing unexpected, unpromised gifts for the first three decades of this century. When we grasped the enormity of the frontier, in the 1940s, 1950s, and 1960s, our enthusiasm and expectations became almost unbounded. It was our enthusiasm and expectations that peaked around 1950, along with a flood of new gadgets to fulfill them. Even as early as the 1960s, we began to realize that technology would permit us to make more kinds of gadgets than we could afford. The question was no longer what technology would allow, but what resources and markets would bear.

Now, at the end of the 1980s, a decade away from the peak of the information frontier, the enthusiasm for the technology frontier has declined to the point where the American public is more likely to inquire into the potential harm lurking in a technological fix than it is to accept its promises. We are at that point in transition, comparable to that in the late 1930s, when the enormity of the new frontier is dawning upon more and more people, but the differences between the old and new frontiers are still not apparent to many. There are still many who see the information frontier as a continuation of the technological frontier: They see the gadgets—the computers, microchips, satellites, fiber optics, etc.—as the frontier, not what people are doing—and dreaming of doing—with information. The situation is not unlike that in the late 1930s, when the physicists conceived how to release nuclear energy, and some saw the prospects in *industrial* rather than technological terms.²

Even as the information frontier peaks at the turn of the century, there will be those who don't see it or can't separate it from the technological frontier with which they have identified themselves. In 1940, it would have seemed preposterous to some—just as America was mobilizing to be the "Arsenal of Democracy"—that the industrial era was now in its late stages of decline. If one were then to suggest that we were approaching the peak of the technological frontier, the response might have been, "Industry, technology? What's the difference?" We can, indeed, come that close to the peak of a new frontier without recognizing where we are—or without distinguishing one frontier from another. At a time when most Americans will be seeking solutions or trying to fulfill their dreams through the exploitation of information, a minority will still seek technological solutions through new

²Rhodes, *The Making of the Atomic Bomb*.

gadgets. Others, ahead of their time, will have already absorbed the implications of the peaking frontier and begin calling out the dangers that lie ahead in this adoration for information.

The enthusiasm for the information frontier should escalate rapidly over the next ten years. Even as the objective measures of the frontier peak (e.g., the fraction of the total national investment in durables), public enthusiasm and expectations should continue to rise dramatically. Within another ten years, the optimism about what can be done with, through, and by information—its management, communication, access, etc.—should become almost unbounded. It seems not improbable that the power of information, in the hands of individuals, will come to be seen as a rival to that of the nation-state,³ that information can be used effectively to prevent war or to wage it, and that information can be exploited to perfect or destroy entire societies. That such power should adhere to information is no stranger than the power attributed to technology and industry, fifty and one-hundred years earlier.

In the first several decades of the next century, some of enthusiasm for the power and potential of information will begin to fade because of excesses, abuses, and failures to meet promises. Yet most of American society is likely to be too absorbed by the excitement of the frontier to notice. By the end of the 2020s or 2030s, however, the declining frontier should have produced some disasters; although the causes are likely to be confused, some will recognize that the roots lie in the American devotion to the power and exploitation of information. And, if the pattern holds, in a few more decades, around 2050, that frontier will have closed.

The next frontier will begin about the turn of the century, but will not be recognized as such by most Americans. If there is a long, thin leading edge of related events extending out for 50 years before the frontier opens (100 years before its peak), then the period from 1950 to 2000 should have been witness to events that presaged the genetic frontier opening around the Year 2000 and peaking in 2050. The DNA work of this century would certainly qualify as such precursor events. But around the turn of the century, we should see some developments that will, in retrospect, mark the beginning of a new frontier. At first, they are likely to be lost in, or confused with, the peaking information frontier. That is, they will be

³For much more than a suggestion of that possibility, see Walter B. Wriston, "Technology and Sovereignty," *Foreign Affairs*, Vol. 67, No. 2, Winter 1988/89, pp. 63-75. Dyson, in *Infinite in All Directions*, p. 185, notes: "Small modern computers and software are good tools for eroding the machinery of totalitarian government."

attributed to the current frontier rather than be recognized as the beginning of the next. For example, the first major developments of the genetic frontier may be seen immediately as simply more *evidence* of the information frontier, perhaps resulting from massive information processing, as has been proposed for the mapping of the human genes. Only later, in the 2030s or 2040s, will some recognize those developments as milestones in the new genetic frontier excitement sweeping over society.

Within twenty or fifty years, we will probably be able to read the message that is written in the DNA . . .⁴

This description of the next fifty years is not typical of the kind of forecasts one now sees in long-range planning projections because it is not an extrapolation of current trends. It focuses on the ideas that will intellectually preoccupy Americans; it projects, on the basis of cyclical patterns, new ideas replacing old, as they have for several past centuries. The projection may not be valid, for reasons that may be apparent now or will become so in the future. But correctness is not the criterion by which the pattern or its interpretation should be judged. Rather, we should be asking whether the framework provides a new or different vantage point and, if so, whether the view is interesting. That is all we should ask of any intellectual device.

⁴Dyson, *Infinite in All Directions*, p. 34.